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Indian Standard

CODE FOR DESIGN AND LAYING OF MINERAL FILTERS FOR TILE DRAIN SYSTEM

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Indian Standard

CODE FOR DESIGN AND LAYING OF MINERAL FILTERS FOR TILE DRAIN SYSTEM

Farm Drainage Tiles Sectional Committee, AFDC 47

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Indian Standard

CODE FOR DESIGN AND LAYING OF MINERAL FILTERS FOR TILE DRAIN SYSTEM

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 November 1981, after the draft finalized by the Farm Drainage Tiles Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 Filters for sub-surface tile drain systems are usually required when the soil is unstable and contains very fine sand and silt. Clay soils, although of very fine texture, often do not require filters as the soil particles are held with strong cohesive forces and are not easily dislodged due to the flow of water around the soil aggregates.

0.3 Filter is a layer or combination of layers of graded pervious material designed and placed in such a manner as to augment drainage and yet prevent the movement of the soil particles with seepage water. It is also known as *envelope*. The filters are required to be put around the sub-surface tile drains for following two major purposes:

a) *Hydraulic Function* — To provide a zone of higher hydraulic conductivity around the drain tiles. This reduces the head loss and increases the flow into the drain.

b) *Selective Filtering Function* — To check the soil particles from flowing into the drains.

0.4 A filter material is designed on the basis of the granulometric curve of the soil (also called as base material) and based on the slot sizes, perforations or gap width of the drain tiles. The filter design means arriving at a proper combination of different size particles in the filter.

0.5 Three types of filters, namely, organic, mineral and synthetic have been used with varying degree of success.

0.5.1 The organic materials will probably be the most economical. But the reports about its efficacy and durability are quite contradictory. Therefore, acceptable standards have not emerged so far with respect to these materials.

0.5.2 The sand-gravel filter which consists of a mixture of different size particles from fine sand to small gravel have been reported to be most effective even under the worst soil conditions. However, care has to be exercised in designing the mixture of different size particles.

0.5.3 The synthetic material is relatively new in its use as a filter material. It does not have general applicability for all kinds of soils. Also, since synthetic material filters are generally produced in the form of thin porous sheets of fibre, the first objective of using the filter material, that is, hydraulic function is not fulfilled.

0.6 Considering the above, the mineral filter material, namely, the mixture of sand and gravel of varying sizes have been covered in this standard.

0.7 Though the method for design of filters has been covered in this standard, problem may arise in deciding the proper filter if the soil, in the area to be drained, consists of widely varying textural groups. Under this situation, a single design filter cannot be used but it will have to be designed on the basis of different particle size distribution curves of soils representative of different sub-areas of total drainable area.

0.8 In preparation of this standard, besides deriving assistance from Water Technology Centre, Indian Agricultural Research Institute, New Delhi, considerable assistance has also been taken from the following:

> Luthin, J. N. Drainage of agricultural lands. American Society of Agronomy, U.S.A.
>
> Knops, K. A. C. and Zuidema, F. C. Report on the use of different cover and envelope material for sub-surface drainage. Ministry of Foreign Affairs, Netherlands.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers criteria for design and laying of mineral filters for tile drain system.

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*Rules for rounding off numerical values (*revised*).

2. DESIGN OF FILTER

2.1 The design of the mineral (sand-gravel) filter material is to be based on the property of the soil that is encountered around the proposed drain tile depth. For this purpose, the granulometric curve of the soil (*see* Fig. 1) is first to be obtained. This curve gives the relation between the particle size and the percentage by mass of soil, larger than the given size. Two straight lines are then drawn parallel to the particle size axis from the 50 percent larger and 85 percent larger points.

2.2 The intersection of these lines with the particle size distribution curve are marked '*a*' and '*b*' respectively (*see* Fig. 1). Thus, '*a*' represents the size of particles than which 50 percent of the soil material by mass are larger and '*b*' represents the size of particles than which 85 percent of the soil by mass are larger.

2.2.1 The products (12) × (*a*), (58) × (*a*), (12) × (*b*) and (40) × (*b*) are then calculated. These products represent certain particle sizes and the points corresponding to the products are marked on the two horizontal lines already drawn (*see* Fig. 1).

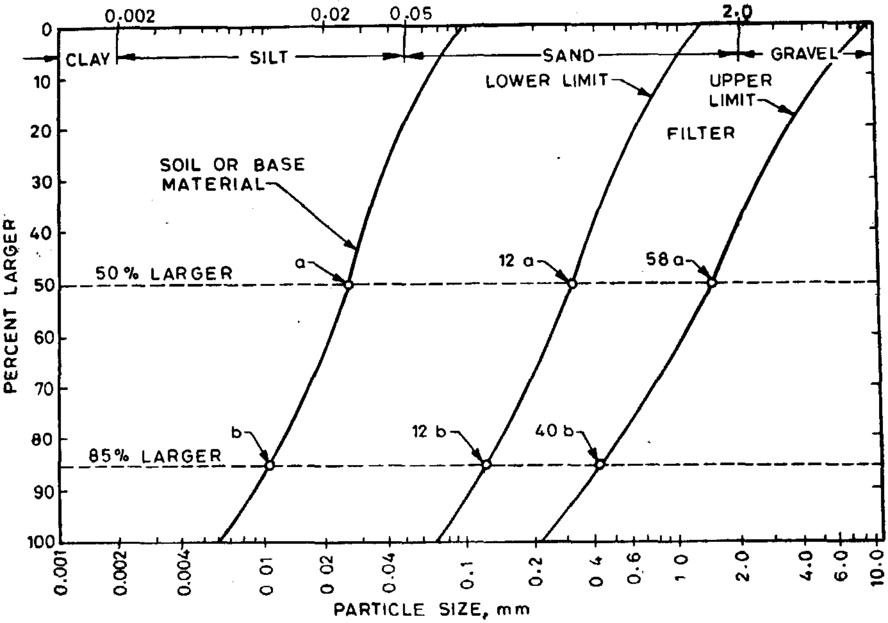

FIG. 1 GRANULOMETRIC CURVES OF BASE MATERIALS AND THE DESIGN FILTER

2.2.2 Two smooth curves are then drawn, one passing through the points marked by the products (12) × (*a*) and (12) × (*b*), and the other through the points marked by (58) × (*b*), and (40) × (*b*). While drawing these curves, care is taken to orient them, as far as possible, parallel to the particle size distribution curve of the soil.

2.2.3 These two curves are, respectively, the lower and the upper limits of the particle size distribution curve for the proposed design of filter material for the given soil (*see also* **0.7**).

2.3 An ideal situation would be that, when the particle size distribution curve of the sand gravel filter passes through the middle of the upper limit and the lower limit curves.

2.3.1 The next best situation would be the one when the particle size distribution curve of the sand-gravel filter lies within these two limits and is more or less parallel to these. However, if naturally available material does not conform to the above limit, the next step shall be to prepare the filter by mixing appropriate proportions of different size particles such that the granulometric curve of the prepared material conforms to the above-mentioned criteria.

2.3.2 If the filter material is finer than that represented by the lower limit curve, the flow of water is likely to be impaired. If the filter material is coarser than that represented by the upper limit curve, the soil filtering ability of the filter material is likely to be impaired.

2.4 The procedure given under **2.2** may lead to some problem, if the soil material has a large proportion of very fine non-cohesive material, such as very fine sand or silt. Under this situation, it would be observed that a large percentage of the filter designed on the basis of above-mentioned procedure will be smaller than the recommended slot width of the drain tiles (0·6 to 1·0 mm in case of rigid PVC pipes), and much smaller than the gap width between the clay tiles (about 3 mm). Under this situation, the granulometric curve of the design filter material should be so modified that the following two criteria are also satisfied:

a) 85 percent larger size of the filter should not be smaller than half the slot size; and

b) Not more than 10 percent of the filter should pass through 0·25 mm diameter sieve.

2.4.1 In addition to the above, 100 percent of the filter should be smaller than 40 mm and 90 percent of the filter should be smaller than 20 mm.

NOTE — This criteria is to be satisfied to avoid excessive proportions of large size particles in the filter which might result if the criteria under **2.2** was adopted. Larger size particles in the filter will result in larger pores between filter particles and will increase the possibility of large quantities of soils inflow into the filter material.

2.4.2 Even after satisfying this criteria, attempt should be made to keep as much portion of the particle size distribution curve of the filter as possible within the upper limit and the lower limit curves mentioned under **2.2** and at the same time approximately parallel to them.

3. LAYING OF THE FILTER

3.1 The filter should be so laid that the coarsest material in the filter is placed adjacent to the drain tile and the finest material adjacent to the soil. However, this may be an impractical proportion to follow in the field installation of filters. In practice, the filter, which is a mixture of various proportions of different size particles, is used as such, without making any special effort to stratify the material with respect to the sizes. The method used, is first to dig a trench. A minimum of 100 mm thick layer of envelope material is placed at the bottom of the trench. Thus, the trench depth should be such that when the drain tile is placed on top of the 100 mm, *Min* sand-gravel filter bed, the pipe centre line should be at the design depth of the drain tile.

3.2 The trench width should also be such that for the given diameter of the drain tile, a minimum of 100 mm thick layer of the sand-gravel filter can be placed on the sides of the drain tile.

3.3 Finally, a minimum of 100 mm thick layer of sand-gravel filter is put on the top of the pipe and the trench is back-filled.

3.4 Thus there should be a minimum thickness of 100 mm of the sand gravel filter all around the drain tile. There is a possibility of reducing the thickness of the filter on the top of the drain tile if a sheet of impermeable material is placed on the top of the filter and of width equal to that of the trench.

NOTE — Though the minimum of 100 mm has been stipulated for thickness of layer but in heavy soil it may be reduced to not less than 50 mm.